Identification of Viruses from Maize and Grass Hosts

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Abstract

Survey of viruses infecting maize and grasses was conducted in western, central and southern parts of Ethiopia during the 1994/1995 season. Viruses were detected by serological tests, ELISA and electron microscopy. Maize Streak Virus was detected in most of the maize samples collected. Sugar Cane Mosaic Virus, Maize Dwarf Mosaic Virus, Johnson Grass Mosaic Virus? and Maize Mottle Chlorotic Stunt Virus were detected in some samples. This is the first report of the presence of the latter three viruses in the country. Some viruses were also detected in five grass species: *Digitaria* sp, *Eluesine* sp, *Panicum* sp, *Pennisetum* sp and *Rottboellia* sp. Further studies indicated that these grasses are overwintering hosts for maize viruses and/or their vectors.

Introduction

Maize is one of the main cereals grown in Ethiopia. The average crop yield is very low due to a number of constraints among which viral diseases play an important role. About 32 viruses are reported to infect maize worldwide, of which thirteen occur in Africa (Thottappilly et al. 1993). In Ethiopia, Maize Streak Virus (MSV), transmitted by leafhoppers (*Cicadulina* spp), is the major disease of the crop. Several grass species are known to play an essential role in the ecology of maize viruses and/or their vectors (Brunt et al. 1990). The occurrence of MSV in Ethiopia was reported by a number of workers based on visual symptoms (Bos 1974, Teclemariam 1986, Assefa & Tewabech 1992) and by serological tests (Mesfin et al. 1991). Among the other viruses known to infect maize, Mengistu (1982) suspected the presence of Sugar Cane Mosaic Virus (SCMV) in maize and sorghum samples at Nazareth. Abdulnasir et al. (1990) detected SCMV from maize and sorghum samples in the Harar area. Despite the awareness of its importance, information on the natural hosts (e.g. grasses) of MSV and its vectors is not available. Moreover, the occurrence, distribution and relative importance of other maize viruses and their alternate hosts have not been studied in Ethiopia. In this paper we report results of surveys conducted between 1993 and 1995.

Materials and Methods

Sample collection

Leaf samples of maize and other graminaceous hosts with virus-like symptoms such as streak, mosaic, mottle, and stunted growth were collected from various locations in major maize growing areas in western, central and southern Ethiopia. Virus incidence was determined visually by counting the number of infected plants along the two diagonals of a 5 m x 5 m area; samples were taken from five spots at each site and the mean of percentages of infected plants were thus determined. For some samples with symptoms suggestive of maize streak virus, transmission test was done by back-inoculating with its vector, *Cicadulina* sp in the greenhouse. The potyvirus nature of the symptoms was confirmed by mechanically inoculating to the susceptible maize cultivar sweet corn. The viruses were maintained for further analysis in the same host.

Serological tests

Serodiagnosis was done by enzyme linked immunosorbent assay (ELISA) to Maize Streak Virus (MSV), Sugar Cane Mosaic Virus (SCMV), Maize Dwarf Mosaic Virus (MDMV), Johnson Grass Mosaic Virus (JGMV) and

Sorghum Mosaic Virus (SrMV). Either of the double antibody sandwich (DAS) ELISA (Clark & Adams 1977) or direct antigen coating (DAC) indirect ELISA (Hobbs et al. 1987) was followed as described. The color change from colorless to yellow due to positive reaction was monitored visually and by ELISA reader at absorbence of 405 nm. A sample was considered negative when the absorbance value at 405 nm is at least twice that of the mean readings of the healthy control.

Electron microscopy

$CaCl_2$-dried samples were homogenized with 2% phosphotungstic acid (pH 7.0), placed in copper grid and examined under an electron microscope at the Institute of Seed Pathology, Denmark. Part of the samples have undergone immunosorbent electron microscopy in the UK using antiserum to Maize Dwarf Mosaic Virus (MDMV), Maize Stripe Virus (MStV), Maize Mottle Chlorotic Stunt Virus (MMCSV) and Maize Mosaic Virus (MMV).

Results and Discussion

Results of our studies confirmed that MSV is the most dominant virus in maize in Ethiopia. The virus was detected in most of maize fields surveyed (Table 1) and other graminaceous plants near maize fields which may act as overwintering hosts for the virus or its vector (Table 2). Previously MSV was reported mostly from the lowlands of Ethiopia (Mesfin et al. 1991) but the current information indicates that it is becoming increasingly widespread in mid-altitude areas such as Ambo, Meti and Ginchi.

Furthermore, SCMV which has been previously reported only from areas around Harar (Abdulnasir 1990), is detected in economically important proportions in some of the areas surveyed. For example, 15-20% of the off-season maize in the Bako area was infected by this virus. It is known to cause a serious loss in other East African countries (Louie 1980). Since small percentages of SCMV can be seed-borne in maize (Brunt et al. 1990), it is probable that the virus is introduced to Ethiopia with seeds from neighboring countries.

Serological tests showed that most of the potyvirus isolates in Ethiopia belong to SCMV while MDMV and JGMV were detected in some of the samples (Table 3). Previously these viruses have been classified as strains of either SCMV or MDMV (Shukla et al. 1989) but are now considered to be distinct.

The occurrence of MDMV, JGMV, MMCSV in maize is reported here for the first time in Ethiopia. MMCSV is an isometric virus endemic to many African countries (Thottappilly et al. 1993). The virus is transmitted in nature by *Cicadulina* spp in a similar manner to MSV; the host range of this virus is limited to maize (Thottappilly et al. 1993). Whether the Ethiopian isolate of MMCSV has the same properties as those in other African countries has to be investigated further. Except for MMCSV all other viruses are detected from one or more grass hosts (Table 3). All the grass species in which viruses were detected in this study are known to harbor the respective virus in other countries, suggesting that they may play an important role in virus epidemiology in Ethiopia. SrMV, MStV, MMV were not detected from any of the samples tested.

Maize streak, which was reported to be economically important in the western lowlands of Ethiopia some 10 years ago (Teclemariam 1986), has now spread rapidly to other areas and become one of the major diseases in many parts of the country. In addition, this report shows that other viruses are also becoming increasingly important in many areas. Detailed survey to identify virus strains and their distribution, study of the host range and seasonal fluctuation of their vectors, as well as the development of resistant varieties are important aspects of future research. This requires a coordinated and multdisciplinary approach of virologists, vector entomologists, and breeders.

Table 1. Incidence of MSV on maize in parts of western, central and southern Ethiopia

Region	Location	Altitude (m)	Mean infected plants (%)
Wellega	Lugo	1500	8
	Haro Alleitu	1450	10
	Ukie	1450	9
	Loko	1440	8
	Didessa	1400	2
	Girma Gudatu	1500	1
	Boreda	1800	4
	Anger	1550	6
	Chari	1500	1
	Sire	1850	2
	Moto	1820	3
	Moto Chonkorosa	1800	4
	Angobo Dambo Danku	1820	4
	Bako	1750	10
	Tulu Hanku	-	10
	Shaka	1850	10
	Ejaji	1800	13
	Jato Dekel	1900	5
Shewa	Ambo	2225	3
	Meti	2200	5
	Ginchi	2200	1
	Melkassa	1700	1
	Meki	-	2
	Alaba	-	2
Sidamo	Awssa	1650	1

Table 2. Viruses other than MSV detected on maize*

Virus detected	Place of sample collection
SCMV	Ambo, Anger, Bako, Lugo, Loko, Ukie, Awassa, Tikur Inchini
MDMV	Bako, Cheka, Hante
JGMV	Bako, Anger, Ukae
MMCSV	Bue, Sire, Lugo, Warago-Kokomta

* *SCMV=Sugar Cane Mosaic Virus, MDMV=Maize Dwarf Mosaic Virus, JGMV=Johnson Grass Mosaic Virus, MMCSV=Maize Mottle Chlorotic Stunt Virus.*

Table 3. Grass hosts in which viruses infecting maize were detected*

Host	Virus(es) detected	Place of collection
Digitaria sp	MSV, SCMV/MDMV	Lugo
Eluesine indica	MSV, SCMV/MDMV	Ambo
Eluesine sp	MSV	Horo Alleltu
Panicum sp	MSV	Loko
Pennisetum sp	SCMV/MDMV	Bareda
Rottboelia exaltata	MSV	Horo Alleltu, Lugo

MSV=Maize Streak Virus; others are the same as in Table 2

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References

Abdulnasir Bedri, Fuchs E, Zieger G. 1990. Proofing von Genotypes Des Maires auf Resistance gagenuber dem maize dwarf mosaic virus (MDMV) und sugar cane mosaic virus (SCMV). Tag. Ber. Akad. Landwirtsch, wiss, Berlin 294s. 151-160.

Assefa Teferi, Tewabech Tilahun. 1992. Review of maize diseases in Ethiopia. pp. 43-51. In Proceedings of the First Maize Workshop of Ethiopia. IAR: Addis Ababa.

Bos L. 1974. Viruses of pulses and other crops. IAR: Addis Ababa, Ethiopia.

Brunt A, Crabtree K, Gibbs A. 1990. Viruses of Tropical Plants. CAB International: Wallingford, UK.

Clark MF, Adams AN. 1977. Characteristic of microplate method of enzyme-linked immunosorbent assay for the detection of plant viruses. Journal of General Virology 34:475-482.

Hobbs HA, Reddy DVR, Rasjshwari R, Ready AS. 1987. Use of direct antigen R coating and protein A coating ELISA procedure for the detection of three peanut viruses. Plant Disease 71:747-749.

Louie R. 1980. Sugar cane mosaic virus in Kenya. Plant Disease 64:944-947.

Mengistu Hulluka. 1982. Diseases of sorghum at some locations in Ethiopia. Ethiopian Journal of Agricultural Sciences 4:45-54.

Mesfin T, Den Hollander J, Markham PG. 1991. *Cicadulina* species and maize streak virus in Ethiopia. Tropical Pest Management 37:240-244.

Shukla DD, Tosic M, Jilka J, Ford RE, Toler RW, Langman AAC. 1989. Taxonomy of potyviruses infecting maize, sorghum and sugar cane in Australia and the United States as determined by the reactivities of polyclonal antibodies directed towards virus-specific N-termini of coat proteins. Phytopathology 79:223-229.

Teclemariam Woldekidan. 1986. Virus diseases in maize: a situation report. Ethiopian Phytopathological Committee (EPC) Newsletter. EPC: Addis Ababa, Ethiopia.

Thottappilly G, Bosque-Perez NA, Rossel HW. 1991. Viruses and virus diseases of maize in tropical Africa. Plant Pathology 42:494-509.